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***Body structure and the physical activity***  
***The formation of body structure and body development of***  
***Hungarian children depending on their leisure-time passions***

PhD Thesis

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## **Introduction**

I have analyzed the effect of physical activity and inactivity on body shape and body composition in prepubertal, pubertal and postpubertal children.

I hypothesized the followings:

1. The level of physical activity and inactivity changes with age in both genders.
2. Physical activity is not necessarily in inverse proportion to physical inactivity: active children might do more inactive pursuits than the inactive ones.
3. The habitual physical activity of children living in settlements with different urbanization level is different; furthermore, the physical activity of children depends on the socio-economic status of their families.
4. The level of physical activity in children is influenced by the parental attitude towards everyday physical activities.
5. The body structure of children belonging to the same chronological age but having different physical activity level shows significant difference; that results from the difference between the development of the bones and muscles and the difference between the amount of accumulated fat.

These hypotheses can be proved or rejected by answering the following questions:

1. Can differences in age and gender be revealed concerning physical activity and inactivity?
2. What connections can be found between leisure-time passions with and without physical activity?
3. Can significant difference be demonstrated in the spare time activities of children living in different micro and macro socio-economic environment?
4. According to several studies, during prepuberty parents are the most important reference group for the youth; parental attitude towards different everyday activities is determining for their children. That raises the question: how do the physical activities of the parents influence the physical activity of their children of prepubertal, pubertal and postpubertal age in the examined age interval?

5. Can difference be demonstrated in the body structure (body composition and body shape) of children of the same chronological age but with different physical activity level? Furthermore, the possibility of nutritional status influenced by physical activity or inactivity level was analyzed.

6. Eventually, I have analyzed if any of the examined environmental factors have significant importance considering their motivating effect on physical activity or inactivity.

### **Subjects and methods**

During the 2nd Hungarian National Growth Study – Bodzsár and Zsákai 2003-2006 – (Bodzsár and Zsákai 2008, 2012) information was collected with questionnaires about the nutritional habits, lifestyles and leisure-time passions of children between 3-18 years, with the help of anthropometric data collection and the examination of body composition with instrumental technique. Having used this data I try to prove my hypotheses. The examined sample of children between 7-18 years (9974 boys and 9610 girls) is the subsample of this previously mentioned data.

The anthropometric examinations were carried out with standard equipment (Sieber-Hegner anthropometric instruments, Lange-type caliper), according to the standardized techniques, with the recommendation of IBP (Weiner and Lourie 1969, Bodzsár and Zsákai 2004).

The elements of body composition (bone, muscle and fat) were estimated with the Drinkwater-Ross (1980) four-component method.

Nutritional status was estimated by using BMI's age-dependent cut-off points worked out by Cole and his contributors (2000, 2007). According to this, four groups were created: underweight, obese, overweight children, and children with normal nutritional status.

Body proportions of children with different levels of physical activity were examined with the z-profile of Ross and Wilson (1974) that uses data of the unisex human phantom.

The morphological classification was performed in two ways: the body shape of the children was characterized according to the (1) Heath-Carter somatotyping method (Carter and Heath 1990) and the (2) Conrad growth type components (Conrad 1963).

Children were grouped with the Hollingshead-index (Hollingshead 1957) according to their socio-demographic status as follows: subgroups of bad, average and good socio-demographic status.

The urbanization level of the settlements were estimated according to the number of their residents.

The physical activity of the children and the parents was examined with questionnaire.

The variation of age and gender of the examined body sizes and body composition was described with the following statistical parameters: number of subjects (n), mean ( $\bar{x}$ ), median (Me), standard error of mean (SE), minimum ( $V_{\min}$ ), maximum ( $V_{\max}$ ) and standard deviation (SD). The analysis of differences in age and gender was performed with the method of variance analysis, and the comparison between subgroups was achieved with the Scheffe-type pairwise comparison and Student's t-test. The homogeneity examination of subgroups created on the base of different aspects was performed with the  $\chi^2$  test (Hajtman 1971). The differences between genders of the average three-dimensional somatotypes and the differences between various subgroups were examined with a modified analysis of variance, the SANOVA method (Carter et al 1983, Carter and Heath 1990).

The analysis of the connection between the environmental factors and the physical activity, and also between the environmental factors, the physical activity and the nutritional status was achieved with cluster analysis (Hajtman 1971). During these analyses all my hypotheses were tested at 5 % level of random error in the computations by using the SPSS for Windows v.14.0 software.

## **Results and discussion**

Analyzing the everyday physical activity and inactivity of Hungarian children between 7-18 years, I wanted to examine what effect the level of their activity has on their body shape and body composition.

According to my hypotheses, the level of physical activity and inactivity changes with age; physical activity and inactivity are not necessarily in inverse proportion to each other; the habitual physical activity of children living in settlements with different urbanization level is different; the level of physical activity of children depends on the socio-economic status of their families; the level of physical activity is influenced by the parental attitude towards everyday physical activities; and the body structure of children belonging to the same chronological age but having different physical activity level shows significant difference.

These hypotheses have been proved with answering the questions of the introduction, presented below.

### *1. The parameters of the physical activity of children according to age and gender.*

Examining the extracurricular, active and passive leisure time passions of children between 7-18 years, we can assume that the prevalence of children with active habits are higher in boys than in girls. The amount of habitual physical activities decreases in both genders towards adulthood.

The relative prevalence of those who only do exercise in P.E. lessons significantly decreases until the age 12 in both genders, then it begins to increase again. The prevalence of children having average amount of exercise (1-6 hours per week) shows a tendency opposite to this; whereas the prevalence of active children (having exercise 7-14 and more than 15 hours per week) continually increases from age 7 to age 18.

The decreasing tendency of the prevalence of those who do not do any sports during childhood can possibly be explained with the fact that parents make children go to different sports clubs. The growing tendency of prevalence of inactivity shown in puberty can be explained in more ways: adolescents are in their „terrible teens”, they try to oppose parental guidance, therefore they probably neglect sports; or they can supposed to be very much occupied with their studies, preparing for the A-level exams, therefore leaving less time for sport.

Sedentary activities mostly done at the expense of physical activities are watching TV and using the computer. Similar TV-watching habits can be observed on weekdays in both genders: until puberty the prevalence of those who do not or rarely watch TV decreases; however, it begins to increase in the years of postpuberty. It is probably because in puberty children are apt to back out of parental control, whereas in postpuberty, because of the increasing pressure on them (studying, preparing for A-level exams), they disregard sports activities. The prevalence of these children reach the very high 60% in the age of 13-14. The examination of weekend TV-watching habits show even more shocking results: more than 75% of the children spend more than two hours per day in front of the television, regardless of gender. Prevalence of children spending one hour or less than one hour per day with watching TV is very low, while the prevalence of those who hardly ever watch TV is negligible, regarding the whole age interval.

On weekdays boys spend much more time on computers than girls. Towards adulthood children of both genders tend to use computers more often. That may result from the fact that children need time to learn how to use technology. Similar results came in case of weekend computer usage; however, even greater difference can be distinguished between the genders, in favour of the boys.

On the base of the results above we can declare that Hungarian children and adolescents do much less physical activities than it should be beneficial for their organism, and the significant part of their spare time is filled with sedentary activities.

*2. Connections between leisure-time passions with and without physical activity.*

During the examination of physical activity and the inactive lifestyle separately or together, similar results came out. Children are probably not inactive only in their actual time of resting or sleeping but at the expense of their spare time potentially filled with physical activity.

*3. Analysis of the connection between the different micro and macro socio-economic environment and the spare time activities of the children.*

During the examination of the relationship between the size of the settlements and the level of the physical activity of their residents a new scientific result emerged: the level of extra-curricular physical activity depends on the urbanization level of the residence, but only in the girls. In the prevalence of both active and inactive girls significant differences occurred between the residents of small and large settlements. In the prevalence of active boys this difference cannot be shown.

With both genders the prevalence of inactive children is higher in larger settlements. The reason of this can be that in larger residences there is a wider range of choice of inactive spare time passions.

Another new scientific result is that there are much more active girls living in better socio-economic circumstances. That may result from the fact that families living in relatively good socio-economic circumstances can more easily provide for their children the possibility to do sports and be in sportclubs. In case of the boys, no significant difference emerged between the active and inactive ones, considering their socio-economic status.

*4. The analysis of the connection between the physical activity of the parents and their children.*

I could also confirm as a new scientific result that the physical activity in children is influenced by their parents' physical activity level, the parental attitude towards everyday physical activities. Examination proved that the level of physical activity in children is also greatly influenced by the parents' physical activity level during the upbringing of their children. It can be stated that the more active the parents are, the more active children they have.

*5. The analysis of the connection between the physical activity and inactivity level and the body structure and the nutritional status of children.*

The results revealed that the amount of bone and muscle is higher in children with greater level of physical activity. In case of bone, the level of physical activity influences it a great deal in boys between 9-11 years and at the age of 17, and in girls between 7-13 years; muscle is influenced by this level in boys in the whole age interval, while in girls mainly during puberty.

Relative and also absolute fat is higher in children with lower level of physical activity, in both genders, during the whole examined age interval.

The prevalence of overweight and obese, and also underweight children is higher in inactive groups than in the active ones, in both genders, during the whole examined age interval.

My hypothesis, which said that the robusticity of bone and muscle is higher in children with higher level of physical activity, while the fat component is higher in children with lower level of physical activity, could be confirmed.

Comparing the body proportions of children with different levels of physical activity with z-profile, the results indicate that significant difference could be shown in case of skinfold: inactive children have a higher amount of subcutaneous fat accumulation in both genders, during the whole examined age interval.

Examining the average somatotype of the children according to physical activity, we can state that active children have much bigger musculoskeletal robusticity than their inactive peers, in both genders; however, their average endomorpha component is smaller, so that they have less subcutaneous fat accumulation. So active children belong to the mesomorph-dominating categories, while inactive ones belong mainly to the endomorpha-dominating somatotype categories.

Comparing the Conrad growth type of children according to their physical activity, results show that the values of metric index of inactive children in girls are higher only in the beginning of their prepuberty, in boys until their puberty, so their trunk is rounder comparing to the trunk of more active children.

No significant differences arose in the values of plastic index (except in boys between the age 10-11 and 15-17) in the groups created according to the level of activity.

*6. The role of the studied environmental factors considering their motivating effect on physical activity or inactivity.*

By analyzing the importance of the studied environmental factors (the size of the settlement, the socio-economic status of the family, the parents' physical activity) on the level of

children's physical activity, I could conclude as a new scientific result that the parental attitude towards regular physical activity during the upbringing is the most important factor in the developing of physical activity habits, independent of age and gender.

As a conclusion, I could confirm on the base of the results that the level of physical activity has a great influence on the body structure and body development of children. More active children have bigger musculoskeletal robusticity than their relatively more inactive peers, who, on the other hand, have much more subcutaneous fat accumulation. I have assessed that in girls the level of extra-curricular physical activity depends on the urbanization level of the residence, in addition, the prevalence of girls with significant physical activity is higher in relatively good socio-economic circumstances; furthermore, active parents have more active children than the inactive ones.

According to the WHO report (2008), containing the results of the body structure and body development examination carried out among children in Europe and North-America, the prevalence of overweight and obese children became very high in the beginning of the 21st century in Hungary as well. This secular trend in the nutritional status of children is also reconfirmed with the results (Bodzsár and Zsákai 2008) of the 1st (Eiben et al, 1983-1986) and the 2nd Hungarian National Growth Study (Bodzsár and Zsákai 2003-2006). This can be explained not only with the significant changes in nutritional habits, but also with the decreasing level of habitual physical activity. On the base of the WHO report (2008), Hungarian children belong to the middle rank in Europe, according to their level of physical activity and the amount of their passive leisure-time activities (in this case, watching TV).

Making physical activity an evidence of children's daily routine should have a great significance; to achieve this stage, the parental attitude towards everyday physical activities is of especial importance.

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